A

REPORT

ON

"POWER THEFT MONITORING"

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE PROJECT PHASE-II

BACHELOR OF ENGINEERING (ELECTRONICS AND TELECOMMUNICATION ENGINEERING)

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SAVITRIBAI PHULE PUNE UNIVERSITY

YEAR 2023-2024

CERTIFICATE

This is to certify that the project report entitles

"POWER THEFT MONITORING"

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ABSTRACT

Power theft is a significant issue faced by power distribution companies worldwide, leading to financial losses and impacting the quality of service for legitimate consumers. This project proposes an innovative solution for power theft monitoring and controlling using a combination of Raspberry Pi, GSM module, and current sensor ADS115 module. The objective of this project is to develop a reliable and efficient system that can detect power theft instances in real-time, send alerts to the concerned authorities, and enable remote control of the power supply to the identified theft points. By implementing this system, the power distribution companies can mitigate losses and improve the overall integrity of the power grid. The system comprises three main components: Raspberry Pi, GSM module, and the current sensor ADS115 module. The Raspberry Pi acts as the central processing unit, responsible for data acquisition, analysis, and control. It interfaces with the GSM module to establish a communication link with the power distribution company's server and send notifications in case of power theft detection. The current sensor ADS115 module is integrated with the Raspberry Pi to measure the current flowing through the distribution lines accurately. To detect power theft, the current sensor module continuously monitors the current levels. Any abnormal fluctuations or discrepancies are considered potential indicators of power theft. The collected data is analyzed by the Raspberry Pi, which applies intelligent algorithms to identify patterns and anomalies associated with power theft. Once a theft instance is detected, the system sends an alert to the designated authorities through the GSM module, enabling them to take immediate action. In addition to monitoring, the system offers control capabilities to tackle power theft effectively. Upon confirmation of power theft, the Raspberry Pi triggers the appropriate relay switches to disconnect the power supply to the theft point. This remote control feature provides a proactive response, reducing the duration of power theft and minimizing financial losses for the power distribution company. Furthermore, the system allows for centralized monitoring and control, enabling the power distribution company to track power theft incidents, generate reports, and analyze the data to identify trends or areas prone to theft. This information can be used to optimize resources and develop targeted strategies to prevent power theft. The proposed solution offers several advantages over traditional power theft detection methods. It provides real-time monitoring, ii immediate notifications, and remote control capabilities. By

leveraging the power of Raspberry Pi and the ADS115 module, the system ensures accurate and reliable data acquisition, analysis, and control. The integration of the GSM module enables seamless communication with the power distribution company, ensuring timely response to power theft instances. In conclusion, this project presents a comprehensive system for power theft monitoring and controlling using Raspberry Pi, GSM module, and current sensor ADS115 module. By implementing this system, power distribution companies can proactively detect and prevent power theft, reducing financial losses, improving service quality, and maintaining the integrity of the power grid.

Keywords: Power grid, IOT, GSM, Raspberry Pi.

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Chapter 1

INTRODUCTION

1.1 Introduction

Power theft is a critical issue that affects power distribution systems worldwide. It leads to significant financial losses for power utility companies and results in an inefficient distribution of electricity resources. To address this problem, we propose a project on power theft monitoring and controlling using advanced technologies. Our project incorporates the Raspberry Pi, GSM module, current sensor, ADS 115 module, and the ThingSpeak IoT server to monitor and control electricity consumption remotely. The objective of this project is to develop a comprehensive solution that detects power theft and allows for real-time monitoring and controlling of electricity supply. By leveraging IoT and communication technologies, we aim to provide a robust and efficient system that can significantly reduce power theft incidents. The core component of our system is the Raspberry Pi, a versatile single-board computer that serves as the central processing unit. It provides the computational power and connectivity required for data acquisition and communication. The Raspberry Pi is responsible for collecting data from various sensors and transmitting it to the ThingSpeak IoT server for further analysis and visualization. To detect power theft, we integrate a current sensor into our system. The current sensor measures the electricity flow in the distribution line, enabling us to monitor the power consumption accurately. Any deviation from the expected consumption patterns can indicate potential power theft activities. The data from the current sensor is processed by the Raspberry Pi and sent to the ThingSpeak IoT server for analysis and storage. To enhance the monitoring capabilities, we incorporate the ADS 115 module into our system. The ADS 115 module is an analog-to-digital converter that allows for precise measurement of electrical parameters, such as voltage and current. By leveraging the capabilities of this module, we can obtain more detailed and accurate data about the power consumption patterns, enabling us to detect power theft more effectively. In addition to monitoring, our system also provides control functionality through the GSM module. This module enables communication via text messages (SMS) and allows authorized personnel to remotely control the electricity supply. By sending specific commands

through SMS, the system can activate or deactivate the power supply to specific areas or individual consumers, effectively curbing power theft activities in real-time. 2 To store and analyze the collected data, we utilize the ThingSpeak IoT server. ThingSpeak is a cloud-based platform that provides data storage, visualization, and analytics capabilities. It allows us to create custom dashboards and generate real-time reports based on the collected data. The integration of the Raspberry Pi with ThingSpeak enables seamless data transfer and efficient management of power consumption information. In conclusion, our project on power theft monitoring and controlling aims to develop a robust and efficient system that leverages advanced technologies to detect power theft, monitor power consumption, and control electricity supply remotely. By utilizing the Raspberry Pi, GSM module, current sensor, ADS 115 module, and ThingSpeak IoT server, we can create a comprehensive solution that addresses the critical issue of power theft. This project has the potential to significantly reduce power theft incidents, leading to improved efficiency in power distribution systems and financial savings for power utility companies.

1.2 Need of Project

Power theft monitoring is a crucial issue faced by power distribution companies worldwide. It not only results in significant revenue loss but also leads to increased electricity prices for honest consumers. In this context, developing a power theft monitoring system using a Raspberry Pi 3B can be an excellent project idea for several reasons:

लोकमत इन्फोग्राफिक्स

शेजाऱ्याला दिली वीज; तर दाखल होईल गुन्हा

नाशिक : घरगुती वापरासाठी असलेली वीज शेजारी राहणाऱ्यांना किंवा एखाद्या दुकानदाराला भाडेतत्त्वावर दिल्याचे आढळून आल्यास संबंधितावर गुन्हा दाखल होऊ शकतो. हा प्रकारदेखील वीज चोरी समजली जात असल्याने परस्पर वीज दुसऱ्याला देणाऱ्यांवर दंडात्मक कारवाई केली जाते. महावितरणने सध्या वीज चोरीवर लक्ष केंद्रित केले असल्याने अशा वीज चोरांवरही कारवाई होणार आहे.

जिल्ह्यात १९५ जणांवर गुन्हे दाखल

विजेचा गैरवापर व घेतलेल्या कारणांशिवाय दुसऱ्या कारणासाठी विजेचा वापर केल्याचे आढळून आलेल्या जिल्ह्यातील १९५ वीज ग्राहकांवर गुन्हे दाखल करण्यात आले आहे. त्यांच्यावर दंडात्मक कारवाई करण्यात येऊन समज देण्यात आली आहे.

१.२८ कोटींचा दंड वसूल

घेतलेल्या कारणांशिवाय विजेचा इतरत्र वापर करणाऱ्यांमध्ये घरगुती ग्राहक असल्याने कलम १२६ अंतर्गत त्यांच्यावर कारवाई करण्यात आली. गेल्या वर्षभरात अशा १९५ ग्राहकांकडून सुमारे १ कोटी २८ लाखांची दंडात्मक कारवाई करण्यात आली.

आकडे टाकणाऱ्यांची गय नाही

वीजतारांवर आकडे टाकून वीजचोरी करणाऱ्या ग्राहकांवर थेट कारवाई केली जाते. अशा ग्राहकांवर विजेच्या १३५ कलमांतर्गत कारवाई करण्यात आली आहे. त्यानुसार २,५३० ग्राहकांना कारवाईला सामोरे जावे लागले. वीज मीटरमध्ये फेरफार किंवा वीजतारांवर आकडे टाकणाऱ्यांवर कलम १३५ कलमांतर्गत कारवाई केली जाते.

घरगुती वीज दुकानदाराला, कृषीची वीज घराला देणे गुन्हा

घेतलेल्या कारणांव्यतिरिक्त इतर कामांसाठी विजेचा गैरवापर करण्यात आला असेल तर वीजचोरी म्हणून त्यांच्यावर कारवाई केली जाते. अनेकदा घरगुती ग्राहक बाजूच्या दुकानाला किंवा घराला उपजोडणी करून वीज पुरवितात. विजेचा असा गैरवापर करणाऱ्यांवर दंडात्मक कारवाई केली जाते.

वीजचोरी पकडण्यासाठी दक्षता पथक

वीजचोरी पकडण्यासाठी दक्षता पथकाच्या माध्यमातून मोहीम राबविली जाते. वीजचोरी उघड झाली तर संभाव्य वीजचोरीचा कालावधी लक्षात घेऊन दंडात्मक कारवाई केली जाते. अनेकदा हा दंड काही वर्षांसाठीचा देखील असतो.

Hello Nashik
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Figure 1.1: Need of Project

Real-Time Monitoring:
With the help of sensors and software, a Raspberry Pi-based power theft monitoring system can provide real-time data on power consumption and detect any unauthorized use of electricity.

Data Analytics:
The system can collect data on power usage patterns, identify any anomalies, and generate reports to help power companies improve their services and reduce revenue loss.

User-friendly Interface:
The system can be designed with a user-friendly interface that allows consumers to monitor their power usage and detect any unusual activity.

Revenue Loss:
Power theft can lead to significant revenue losses for utility companies, as they are not compensated for the electricity that is being consumed illegally. This can ultimately lead to higher electricity rates for law-abiding customers.

Safety hazards:
Power theft can create safety hazards, as illegal connections and tampering with electrical equipment can cause fires, explosions, and electrocution. This can put the lives of both customers and utility workers at risk.

Operational Costs:
Power theft can also increase the operational costs of utility companies, as they must expend resources to investigate and repair illegal connections, replace damaged equipment, and prosecute offenders.

1.3 Target Community of Project

Attendance is marked after student's biometric identification. For student identification, a fingerprint recognition based identification system is used. Fingerprint features are considered to be the best and fastest method for biometric identification. These features are more secure to use and unique for every person that don't change in one's lifetime.

Utility Companies:
Power theft is a major problem for utility companies, as it results in revenue loss and increased costs. Utility companies can use Raspberry Pi-based power theft monitoring systems to detect and prevent power theft in their service areas.

Government agencies:
Governments can also use power theft monitoring systems to ensure that power is distributed fairly and to prevent losses in revenue. This could be particularly important in areas where power theft is rampant.

Industrial complexes:

Large industrial complexes can use power theft monitoring systems to detect and prevent power theft by employees or contractors. This could be particularly important in industries where electricity usage is high, such as manufacturing or mining. The target community for power theft detection and monitoring would primarily include electric utility companies, regulatory bodies, and law enforcement agencies. Electric utility companies would be interested in implementing power theft detection and monitoring systems to ensure that customers are not stealing electricity, which can lead to revenue loss and increased operating costs. By detecting power theft, they can identify the individuals or organizations responsible and take action to prevent future incidents. IoT-based systems can provide more accurate and real-time data on energy usage and anomalies, making it easier to detect theft and tampering. Regulatory bodies, such as government agencies responsible for regulating the electricity sector, would also be interested in power theft detection and monitoring. These agencies 6 would use the information collected by the utility companies to ensure that all customers are paying for the electricity they use, and to enforce regulations and laws related to energy theft. Law enforcement agencies may also be interested in power theft detection and monitoring. Energy theft is a criminal offense, and law enforcement agencies may use the information collected by the utility companies to investigate and prosecute those who engage in this illegal activity Military facilities would be interested in implementing IoT-based power theft detection and monitoring systems to ensure that energy resources are being used efficiently and to prevent power theft.

Military bases and facilities consume a large amount of energy, and any instances of power theft or inefficient use can lead to increased costs and reduced readiness. By implementing IoT-based systems, military facilities can monitor energy usage in real-time and detect any anomalies or instances of power theft. Military contractors would also be interested in IoT-based power theft detection and monitoring systems. These companies may be responsible for providing energy services to military facilities or supplying equipment used in energy management. By using IoT-based systems, they can improve the efficiency of their operations and reduce the risk of power theft or other energy-related issues. Government agencies responsible for overseeing military operations would also be interested in IoT-based power theft detection and monitoring systems. These agencies are responsible for ensuring that military facilities are operating efficiently and effectively, and that resources are being used appropriately. By implementing IoT-based systems, they can monitor energy usage and detect any instances of power theft or inefficiency, improving the readiness and effectiveness of the military. The target community for power theft detection and monitoring in the army sector would

Figure 1.2: Transmission Line

be any organization or agency that is interested in improving energy efficiency, reducing costs, and ensuring the readiness and effectiveness of military operations. Power theft detection and monitoring would be any organization or agency that is interested in detecting and preventing energy theft, improving energy efficiency, and reducing costs.

Residential Communities:
Residential communities can use power theft monitoring systems to ensure that all residents are paying their fair share of the electricity bill. This could be particularly useful in apartment buildings or gated communities where electricity usage is shared among multiple residents.

1.4 Scope of Project

The scope of power theft detection and monitoring is to identify and prevent any unauthorized use of electricity, which can result in revenue loss for electric utility companies and increased operating costs. Power theft can occur in many ways, including meter tampering, unauthorized connections to the power grid, or bypassing of meters, and can be committed by both individuals and businesses.

The use of this systems can help to improve the accuracy and reliability of energy usage data, allowing utility companies to identify instances of power theft more easily. These systems can also provide real-time data and analytics, allowing utility companies to quickly respond to any anomalies and take appropriate action. 8 In addition to detecting power theft, power theft detection and monitoring can also help to improve energy efficiency. By monitoring energy usage and identifying areas of inefficiency, utility com-

panies can make more informed decisions about where to invest in energy infrastructure and where to implement energy-saving measures. Power theft detection and monitoring is also important for regulatory compliance. Governments and regulatory bodies often require utility companies to report on energy usage and to ensure that all customers are paying for the electricity they use. By implementing power theft detection and monitoring systems, utility companies can ensure compliance with these regulations and avoid any legal or financial penalties. Use GSM in our system provides the numerous advantages of a wireless network system. The government saves the money by the control of theft in energy and also beneficial for customer side and the government side. The scope of IoT-based power theft detection and monitoring includes:

Real-time Monitoring:

IoT-based systems can continuously monitor energy usage in real-time, providing accurate and up-to-date information on energy consumption. This enables utility companies to quickly detect any anomalies or unusual patterns of energy usage that could indicate power theft.

Improved Accuracy:

Traditional power theft detection methods may not be accurate in detecting sophisticated power theft methods, such as meter tampering or bypassing. IoT-based systems provide more accurate data on energy consumption and can detect more subtle changes in energy usage.

Predictive Analytics:

IoT-based systems can use machine learning algorithms to analyze historical energy usage data and predict future energy consumption patterns. This enables utility companies to anticipate potential power theft incidents and take proactive measures to prevent them.

Remote monitoring:

IoT-based systems allow remote monitoring of energy usage, enabling utility companies to monitor energy consumption in hard-to-reach areas and prevent unauthorized access to energy infrastructure.

Cost Effectiveness:

IoT-based systems can be more cost-effective than traditional power theft detection methods, as they require less manual intervention and can provide more accurate data. This can help to reduce costs associated with power theft and improve overall efficiency.

Alerting Authorities:

Once power theft is detected, the Raspberry Pi can be programmed to send alerts to the relevant authorities. This could include sending text message.

Record Keeping:

The Raspberry Pi can also be used to maintain records of energy consumption and power theft incidents, which can be used for future analysis and reporting.

Improved Accountability:

By monitoring energy usage and detecting power theft, the Raspberry Pi project can help to improve accountability and reduce financial losses for electricity providers. Power theft monitoring is to provide a cost-effective, efficient, and accurate solution for detecting and preventing power theft, which can ultimately help to improve the financial stability and sustainability of the electricity sector.

Chapter 2

LITERATURE SURVEY

Table 2.1: Summary of References

Sr.	Title	Year	Author	Description
[1]	Wireless Design for Power Theft Identification Using GSM.	2021	Silpa.S1 , Surya.S2 , Susmitha.S3 , Vasandaradevi. S4 , Manikandan.S5	In this paper, Energy theft monitoring using IoT is an innovative application of internet of things developed to control the power theft remotely over the cloud from anywhere in the world. The system would provide a simple way to detect an electrical power theft without any human interface. The system updates the information in every 10 to 12 seconds on the Think Speak cloud using internet.
[2]	Power Theft Detection in Microgrids.	2017	Aryadevi Remanidevi Devidas and Maneesha Vinodini Ramesh	In this paper they proposed wireless network- based solution for power theft, which is considered as a bane of power grid in most of the developing nations. they have proposed power theft detection algorithm (PTDA) which uses Kirchhoff's Current Law (KCL). they have identified three issues of PTDA when it will be used for micro-grids. To solve those issues with PTDA, they have proposed another algorithm called EPTDNA (Efficient Power Theft Data Networking Algorithm).

Chapter 3

PROJECT REQUIREMENTS AND SPECIFICATIONS

3.1 Block Diagram

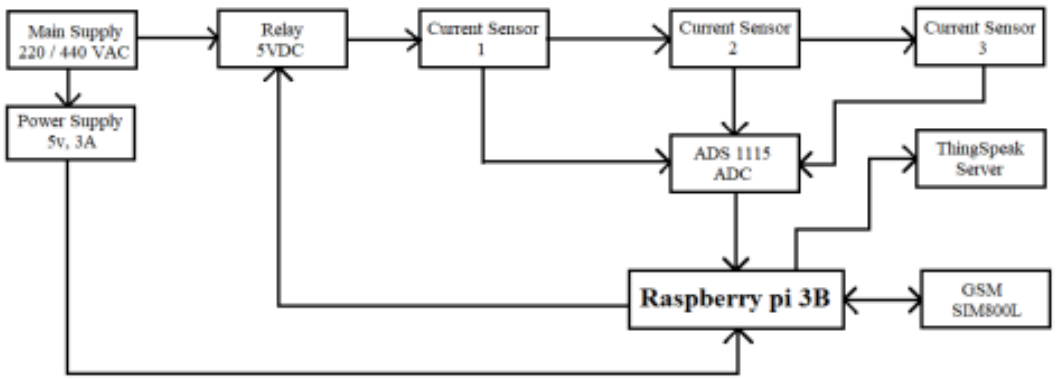

Figure 3.1: Block Diagram of Power Theft Monitoring System

3.1.1 Hardware Requirement

Components:

1. Raspberry Pi 3B
2. Current Transducer Sensor
3. GSM SIM 800L Pinout
4. ADS 1115
5. Relay
6. ThingSpeak Cloud Server

3.2 Hardware Specification

3.2.1 Raspberry Pi 3B

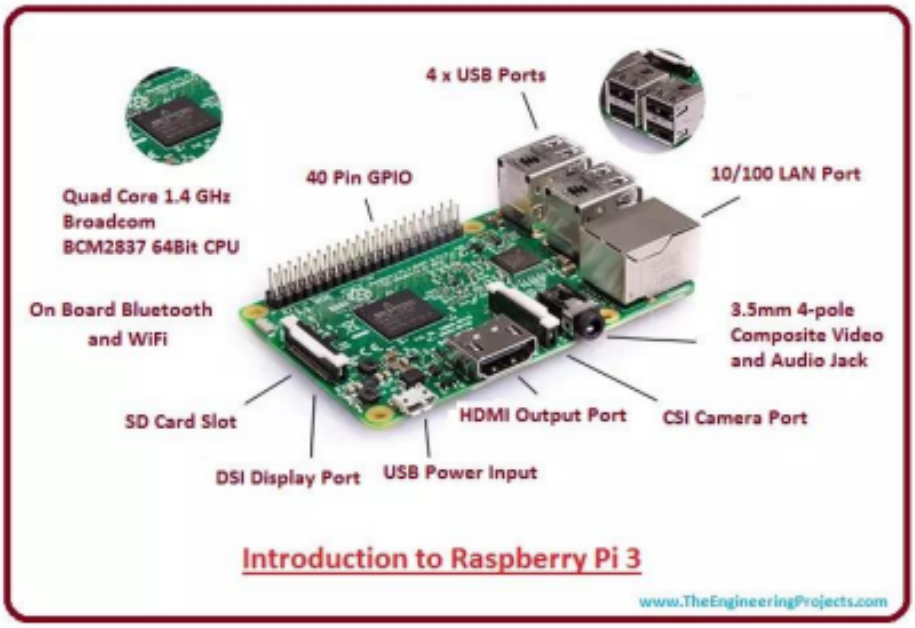

Figure 3.2: Raspberry Pi 3B

Model B is the third generation Raspberry Pi. This powerful credit-card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B. Whilst maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processer, 10x faster than the first generation Raspberry Pi. Additionally it adds wireless LAN Bluetooth connectivity making it the ideal solution for powerful connected designs. The Raspberry Pi 3 Model B is a single-board computer developed by the Raspberry Pi Foundation. It was released in February 2016 and is the third iteration of the Raspberry Pi series. Here is some detailed information about the Raspberry Pi 3 Model B:

1. Processor: The Raspberry Pi 3 Model B is powered by a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor. This processor provides a significant performance improvement over the previous models.

2. RAM: It has 1GB LPDDR2 RAM, which allows for efficient multitasking and running various applications.

3. Connectivity: The board features built-in Wi-Fi 802.11n and Bluetooth 4.2, enabling wireless connectivity for internet access, networking, and connecting to peripheral devices.

4. Ethernet: It has a 10/100 Ethernet port, allowing you to connect the Raspberry Pi directly to a wired network.

5. USB: There are four USB 2.0 ports available, allowing you to connect peripherals such as keyboards, mice, USB storage devices, and more.

6. Video Output: The Raspberry Pi 3 Model B has an HDMI port, which supports Full HD (1080p) video output. Additionally, it also has a composite video port for connecting to older displays.

7. Audio: The board has a 3.5mm audio jack for connecting headphones or speakers, and it also supports HDMI audio output.

8. Storage: It uses a microSD card slot for storage, where you can install the operating system and store your files.

9. GPIO: The Raspberry Pi 3 Model B features a 40-pin GPIO (General Purpose Input/Output) header, which allows for connecting various electronic components and peripherals.

10. Operating System: The Raspberry Pi 3 Model B is compatible with a variety of operating systems, including Raspbian (the official Raspberry Pi operating system), Ubuntu, Windows 10 IoT Core, and several Linux distributions.

11. Power: It requires a 5V micro USB power supply to operate. The power consumption of the board is relatively low, making it energy-efficient. Overall, the Raspberry Pi 3 Model B is a versatile and powerful single-board computer suitable for a wide range of projects, including home automation, robotics, IoT applications, media centers, and more. Its extensive connectivity options and GPIO pins make it highly adaptable for various tasks.

3.2.2 Current Transducer Sensor

Figure 3.3: Current Transducer Sensor

A current sensor, also known as a current transducer or current probe, is an electrical device used to measure the flow of electric current in a circuit. It provides a means to monitor and control current levels in a wide range of applications. Current sensors work based on various principles, including Hall Effect, magnetic induction, and shunt resistor methods. These sensors are commonly used in power systems, industrial automation, renewable energy systems, electric vehicles, and electronic devices. They can measure both AC and DC currents and provide outputs in different forms, such as analog voltage, current, or digital signals. Current sensors offer non-intrusive measurements, meaning they can measure current without interrupting or breaking the circuit. Current sensors are available in different form factors, including clamp-on sensors, split-core sensors, and closed-loop sensors. They come with various current ranges, accuracy levels, and communication interfaces. Some advanced current sensors also offer features like galvanic isolation, overcurrent protection, and temperature compensation. The information provided by current sensors is crucial for applications like load monitoring, power quality analysis, energy management, fault detection, and system protection. By monitoring current levels accurately, current sensors play a vital role in enhancing efficiency, safety, and performance in electrical systems.

3.2.3 GSM SIM 800L Pinout

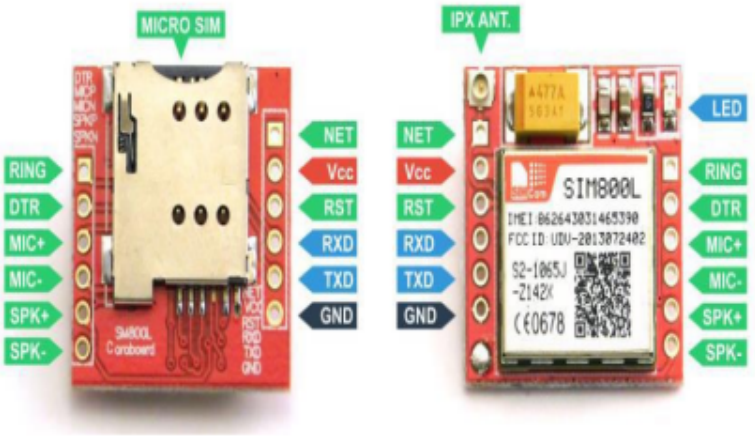

Figure 3.4: GSM Pin Out

The GSM SIM800L module is a quad-band GSM/GPRS module that allows you to add voice, SMS, and data to your project. It operates at 3.3V, and can be easily interfaced with a Raspberry Pi using UART communication. To use the module for power theft monitoring, you can connect it to the Raspberry Pi's UART pins (GPIO14 and GPIO15) and use a suitable power sensor to measure the power consumption of the device being monitored. You can then use the Raspberry Pi to process the sensor data and send SMS alerts using the GSM module if the power consumption exceeds a certain threshold, indicating power theft. There are various software libraries available for interfacing with the SIM800L module using a Raspberry Pi. For example, you can use the Python RPi. GPIO library to interface with the GPIO pins and PySerial library to communicate with the SIM800L module over UART. It is important to note that power theft monitoring may involve legal and regulatory considerations. Therefore, it is recommended to consult with local authorities and experts before implementing such a system.

Pinout (bottom side - left):

- RING (not marked on PBC, first from top, square) - LOW state while receiving call
- DTR - sleep mode. Default in HIGH state (module in sleep mode, serial communication disabled). After setting it in LOW the module will wake up.
- MICP, MICN - microphone (P + / N -)
- SPKP, SPKN - speaker (P + / N -)

Pinout (bottom side - right):

- NET - antenna
- VCC - supply voltage
- RESET - reset
- RXD - serial communication
- TXD - serial communication
- GND – groun

3.2.4 ADS 1115

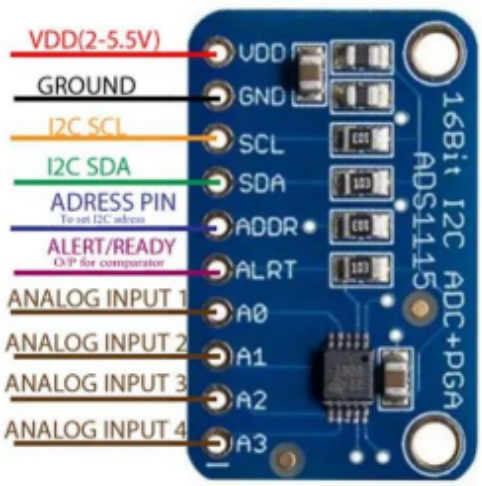

Figure 3.5: ADS 1115

The ADS1115 is a 16-bit analog-to-digital converter (ADC) developed by Texas Instruments. It is a popular choice for measuring analog signals with high precision and accuracy. The ADS1115 offers four differential or single-ended input channels, which can be configured to measure voltage signals within a range of ±2.048V. This ADC communicates with the host microcontroller or computer using the I2C interface, which enables easy integration into various projects and systems. It has a built-in voltage reference and supports continuous and single-shot conversion modes. Additionally, the ADS1115 includes an integrated oscillator, which simplifies the design by eliminating the need for external clock sources. The ADS1115 provides high-resolution and low noise performance, making it suitable for applications such as sensor data acquisition, instrumentation, industrial control systems, and precision measurements.

3.2.5 Relay

Figure 3.6: Relay

A 5VDC relay is an electromechanical device that operates with a 5-volt direct current (DC) power supply. It is commonly used in electronic circuits to control the switching of higher voltage or current loads. The relay consists of a coil, which is energized by the 5VDC input, and one or more sets of contacts that open or close based on the coil's status. The 5VDC relay is designed to handle lower voltage and current levels in the control circuit while providing the capability to switch higher voltages or currents on the load side. It acts as a switch, isolating the control circuit from the load circuit and protecting sensitive electronics from the potentially damaging effects of high voltages or currents.

This type of relay finds applications in a wide range of industries, including automation, robotics, automotive, telecommunications, and home appliances. It is often used for tasks such as motor control, lighting control, power distribution, and safety interlocks. When selecting a 5VDC relay, factors to consider include the coil current, contact rating, contact configuration (normally open or normally closed), and the electrical and mechanical endurance of the relay. These specifications should align with the specific requirements of the intended application to ensure reliable and safe operation.

3.2.6 ThingSpeak Cloud Server

ThingSpeak is an IoT (Internet of Things) analytics platform and cloud server developed by MathWorks. It provides a convenient and powerful way to collect, store, analyze, and visualize data from various IoT devices and sensors. As a cloud-based platform, ThingSpeak enables users to remotely monitor and manage their IoT data from anywhere with an internet connection. It offers an intuitive web interface that allows users to create

custom channels to organize and store their data. Each channel consists of multiple fields that can be used to store different types of data measurements.

ThingSpeak provides RESTful APIs that enable easy integration with IoT devices and allows for real-time data streaming. This allows users to send data to ThingSpeak using HTTP or MQTT protocols, making it compatible with a wide range of IoT devices and platforms. One of the key features of ThingSpeak is its ability to visualize data in real-time. It offers a variety of chart types and widgets that can be customized to display data in a meaningful and interactive manner. Users can also create custom MATLAB® code to perform advanced analytics and generate insights from their data.

In addition to data visualization, ThingSpeak supports data analysis and alerts. Users can define custom analysis algorithms to process and transform data, enabling them to gain deeper insights into their IoT data. Alerts can be set up based on predefined conditions, triggering notifications via email or SMS when specific events occur. ThingSpeak is a versatile platform that supports multiple integration options, including MATLAB, Simulink, and various programming languages such as Python and Arduino.

3.3 Software Requirment

3.3.1 Raspberry Pi Imager

Figure 3.7: Raspberry Pi Imager

Raspberry Pi Imager is a user-friendly software tool developed by the Raspberry Pi Foundation. It is designed to simplify the process of installing operating systems (OS) onto Raspberry Pi devices. The Imager tool is available for Windows, mac OS, and Linux operating systems. The primary purpose of Raspberry Pi Imager is to facilitate the installation of different operating systems onto an SD card or other storage media that can be used with a Raspberry Pi. It eliminates the need for complex manual procedures and command-line operations, making it accessible to users of all experience levels.

Using Raspberry Pi Imager is straightforward. Once the tool is downloaded and

installed on your computer, you can launch it and select the desired OS from a list of supported options. The available choices include official Raspberry Pi OS releases, as well as third-party operating systems like Ubuntu, Manjaro, and RetroPie. After selecting the OS, you can choose the storage medium, such as an SD card or a USB drive, where the OS will be installed. Raspberry Pi Imager will automatically detect and display the available storage devices connected to your computer. It is important to note that any existing data on the selected storage device will be erased during the installation process. Once the OS and storage medium are selected, you can click the "Write" button, and Raspberry Pi Imager will start copying the OS image onto the storage device. The process may take a few minutes, depending on the size of the image and the speed of your storage media. 34

Raspberry Pi Imager also provides advanced options, allowing you to configure Wi-Fi settings, set up SSH access, or customize the OS installation before writing it to the storage device. Overall, Raspberry Pi Imager simplifies the task of installing operating systems on Raspberry Pi devices, making it accessible and user-friendly. It eliminates the complexity of manual installation procedures and ensures a hassle-free experience, whether you're a beginner or an experienced Raspberry Pi enthusiast.

3.3.2 Python idle 3.9

Figure 3.8: Python Logo

Python IDLE (Integrated Development and Learning Environment) is an interactive development environment that comes bundled with the Python programming language. It provides a simple yet powerful environment for writing, testing, and debugging Python code. Python IDLE 3.9 refers to the version of IDLE that is compatible with Python 3.9.

IDLE offers several features to enhance the Python development experience. Its main components include an interactive shell, a code editor, and a debugger. The interactive shell, known as the Python Shell, allows users to execute Python code interactively, making it ideal for quick experimentation and testing. 35

The code editor in IDLE provides a comprehensive environment for writing Python scripts and modules. It supports syntax highlighting, code indentation, auto-indentation, and code completion, making coding more efficient and error-free. The editor also includes features like line numbering, searching and replacing, and multiple undo/redo functionality.

IDLE's debugger is a powerful tool for troubleshooting and fixing code issues. It allows users to set breakpoints, step through code execution, inspect variables, and track program flow. The debugger helps identify and resolve errors, improving code quality and reliability. Python IDLE 3.9 offers several enhancements and improvements over previous versions. It includes the latest features and bug fixes introduced in Python 3.9, such as the new syntax for dictionary merging using the "—" operator, improved type hinting capabilities, and performance optimizations. Additionally, IDLE 3.9 provides an integrated help system that allows users to access Python's extensive documentation directly within the IDE. It offers context-sensitive help, allowing users to retrieve information about Python modules, functions, and classes without leaving the development environment.

Python IDLE 3.9 is platform-independent and is available for Windows, macOS, and Linux operating systems. It is a free and open-source tool that is widely used by beginners and experienced Python developers a like. Overall, Python IDLE 3.9 offers a user-friendly and feature-rich environment for Python development. Its combination of an interactive shell, code editor, debugger, and integrated help system makes it a valuable tool for writing, testing, and debugging Python code efficiently and effectively.

Chapter 4

SYSTEM DESIGN

4.1 System Architecture

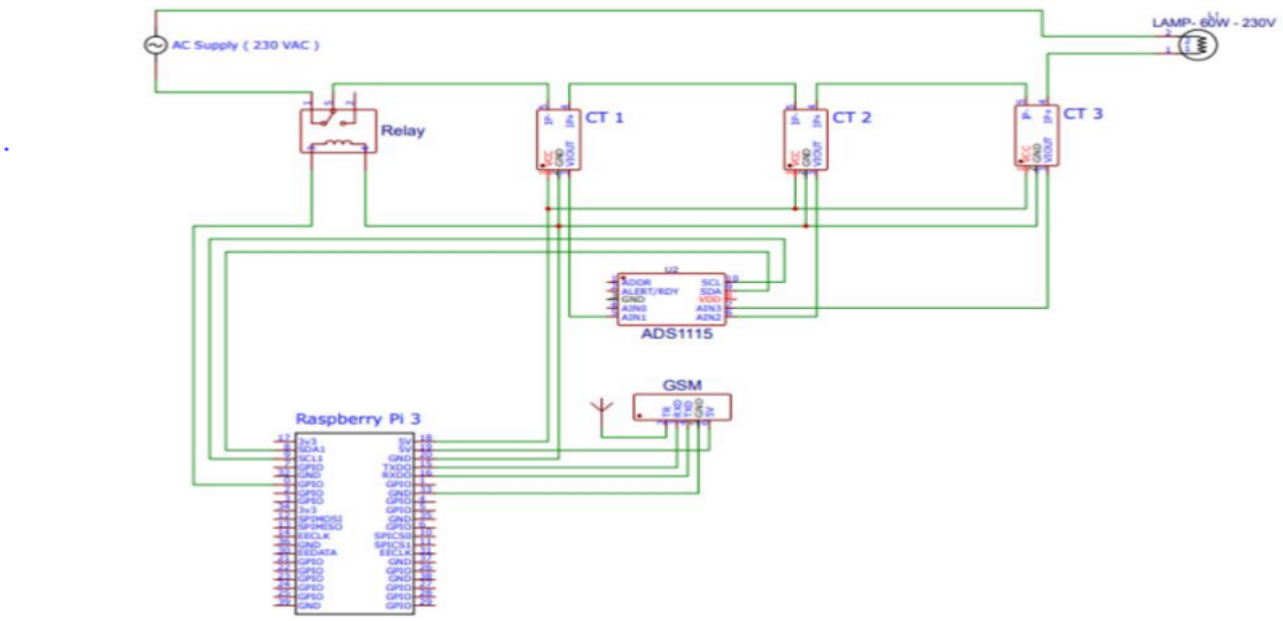

Figure 4.1: Circuit Diagram of Power Theft Monitoring

4.1.1 Working

Power Theft Monitoring and Controlling is a system which is implemented to detect power theft. The main power line is connected to the multiple current transducers and final Load. The current transducer which read the both AC current levels and generate the analog output according to current levels. The ADS1115 sensor is used to convert all current transducers analog data into digital data. The all digital data is send to the Raspberry Pi controller using SDA and SCL I2C communication. The Raspberry Pi reads the all data and upload it to the ThingSpeak cloud server for monitoring purpose.

When any illegal activity happens between transmission lines, the Raspberry Pi

controller received current transducers data and take decision based on power theft detection condition which is when power is theft between CT1 and CT2, the CT1 value is increases because the unknown Load is connected and CT2 value is remain constant. If CT1 is greater than CT2 then power theft is detected and the Raspberry Pi sends Alert text SMS to the MSEB control station with the help of GSM SIM800L module. The same SMS is send when power theft is detected between CT2 to CT3.

When the SMS is received to the MSEB control station, the operator is also able to monitor the all system on ThingSpeak cloud server and the operator also monitor the how much power is consumed by illegal Load. The MSEB has all rights to control the transmission lines, if operator wants to cut off the transmission line of that particular area they can do it using text message function. The operator send the SMS to turn ON and OFF the particular area transmission line.

4.2 Flowchart

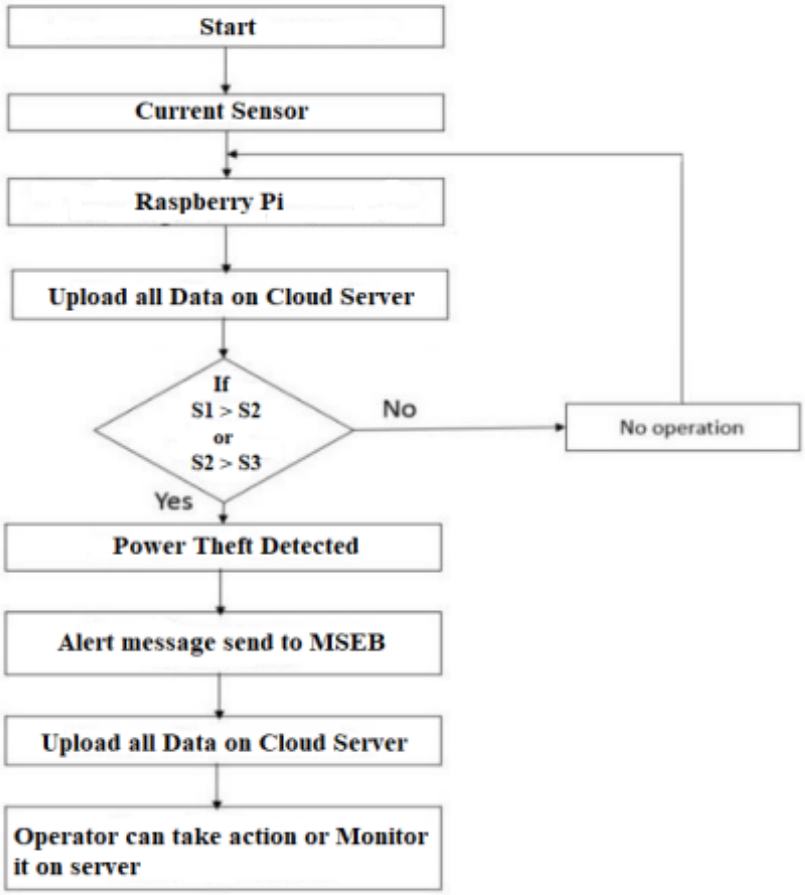

Figure 4.2: Flowchart

- Set up the Raspberry Pi 3B with an appropriate operating system and necessary software.
- Connect the Raspberry Pi 3B to a power source and make sure it is connected to the internet.
- Install sensors on the power lines to measure the voltage and current of the power being consumed.
- Use a current sensor to measure the current flow.
- Write a script in Python to collect the sensor data from the power lines.
- Analyze the sensor data and determine whether there is any discrepancy between the power being consumed and the power being billed for.
- If the analysis shows that there is a discrepancy, generate an alert to notify the relevant authorities.
- Store the data in a database for further analysis.
- Perform periodic checks to ensure that the system is functioning correctly.
- Implement security measures to prevent unauthorized access to the system.

4.3 Design of Printed Circuit Board

- P.C.B. is printed circuit board which is of insulating base with layer of thin copper-foil.
- The circuit diagram is then drawn on the P. C. B. with permanent marker and then it is dipped in the solution of ferric chloride so that unwanted copper is removed from the P.C.B., thus leaving components interconnection on the board.
- The specification of the base material is not important to know in most of the application, but it is important to know something about copper foil which is drawn through a thin slip.
- The resistance of copper foil will have an effect on the circuit operation.
- Base material is made of lamination layer of suitable insulating material such as treated paper, fabric; or glass fibers and binding them with resin. Most commonly used base materials are formed paper bonded with epoxy resin.
- It is possible to obtain a range of thickness between 0.5 mm to 3 mm.

- Thickness is the important factor in determining mechanical strength particularly when the commonly used base material is "Formea" from paper assembly.
- Physical properties should be self supporting these are surface resistivity, heat dissipation, dielectric, constant, dielectric strength.
- Another important factor is the ability to with stand high temperature.

4.4 Designing the Layout

- While designing a layout, it must be noted that size of the board should be as small as possible.
- Before starting, all components should be placed properly so that an accurate measurement of space can be made.
- The component should not be mounted very close to each other or far away from one another and neither one should ignore the fact that some component reed ventilation, which considerably the dimension of the relay and transformer in view of arrangement, the bolting arrangement is also considered.
- The layout is first drawn on paper then traced on copper plate which is finalized with the pen or permanent marker which is efficient and clean with etching.
- The resistivity also depends on the purity of copper, which is highest for low purity of copper. The high resistance path are always undesired for soldered connections.
- The most difficult part of making an original printed circuit is the conversion from, theoretical circuit diagram into wiring layout without introducing cross over and undesirable effect.
- Although it is difficult operation, it provides greatest amount of satisfaction because it is carried out with more care and skill.
- The board used for project has copper foil thickness in the range of 25 40 75 microns.
- The soldering quality requires 99.99
- It is necessary to design copper path extra large. There are two main reasons for this,
  i) The copper may be required to carry an extra large overall current:-
  ii) It acts like a kind of screen or ground plane to minimize the effect of interaction.
- The first function is to connect the components together in their right sequence with minimum need for interlinking i.e. the jumpers with wire connections.

- It must be noted, that when layout is done, on the next day it should be dipped in the solution and board is move continuously right and left after etching perfectly the board is cleaned with water and is drilled.
- After that holes are drilled with 1 mm or 0.8 mm drill. Now the marker on the P. C. B. is removed.
- The Printed Circuit Board is now ready for mounting the components on it.

4.5 Soldering

- For soldering of any joints first the terminal to be soldered are cleaned to remove oxide film or dirt on it. If required flux is applied on the points to be soldered.
- Now the joint to be soldered is heated with the help of soldering iron. Heat applied should be such that when solder wire is touched to joint, it must melt quickly.
- The joint and the soldering iron is held such that molten solder should flow smoothly over the joint.
- When joint is completely covered with molten solder, the soldering iron is re¬moved.
- The joint is allowed to cool, without any movement.
- The bright shining solder indicates good soldering.
- In case of dry solder joint, a air gap remains in between the solder matenal and the joint. It means that soldering is improper. This is removed and again solder¬ing is done.
- Thus in this way all the components are soldered on P. C. B

Chapter 5

RESULT

This involves testing the basic functionality of power theft monitoring system, such as detecting power theft, generating alerts, and recording data accurately. Evaluate the performance of power theft monitoring system by simulating different scenarios and measuring its response time, accuracy. Test the integration of power theft monitoring system with other components, such as sensors, data storage systems, and communication modules, to ensure seamless operation.

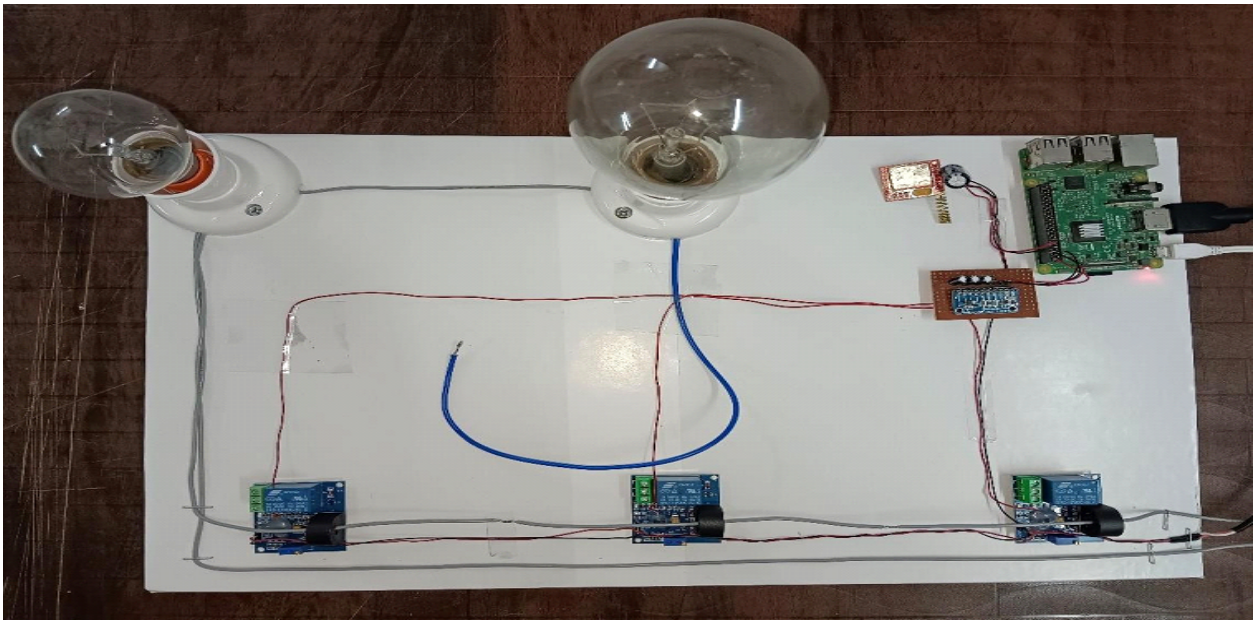

Figure 5.1: Power Theft Detection System

This is the actual image of Power Theft Monitoring and Controlling System. Which includes the Raspberry pi, ADS1115, Current Transducers, GSM SIM800L, Lamp Holder with 60W Lamp and Transmission lines.

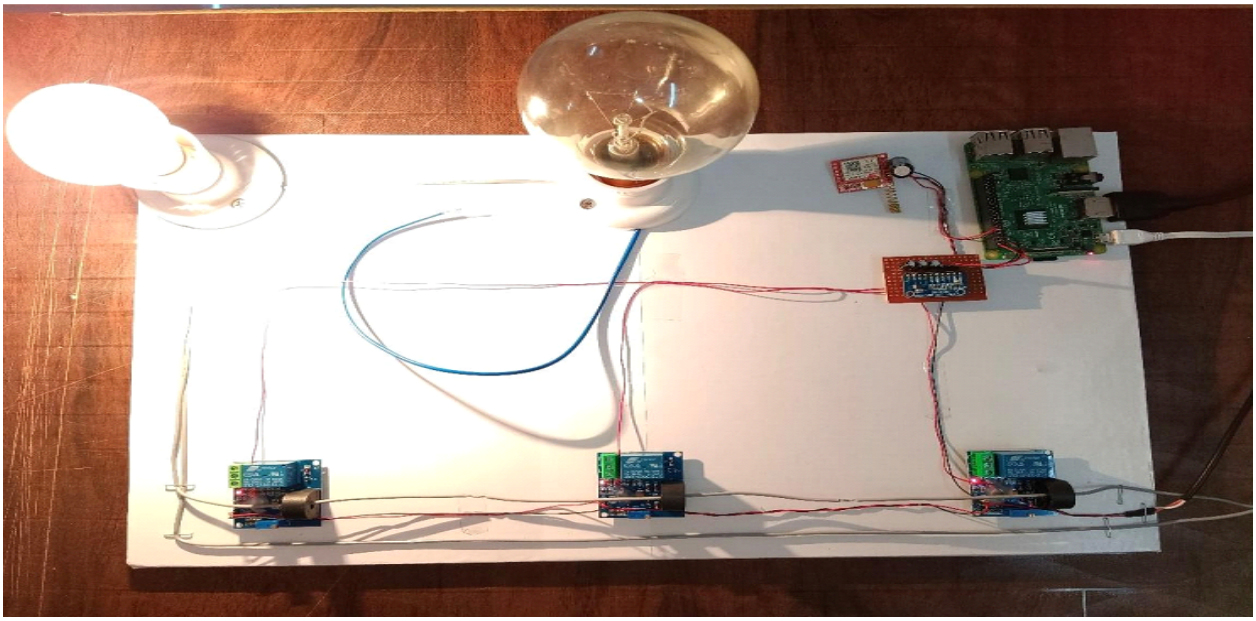

Figure 5.2: When Load is Connected

The load is connected to the transmission line and it shows a legal load consumption. At that time the transmission lines current is measured by the raspberry pi and it upload the real time data on the ThingSpeak cloud server.

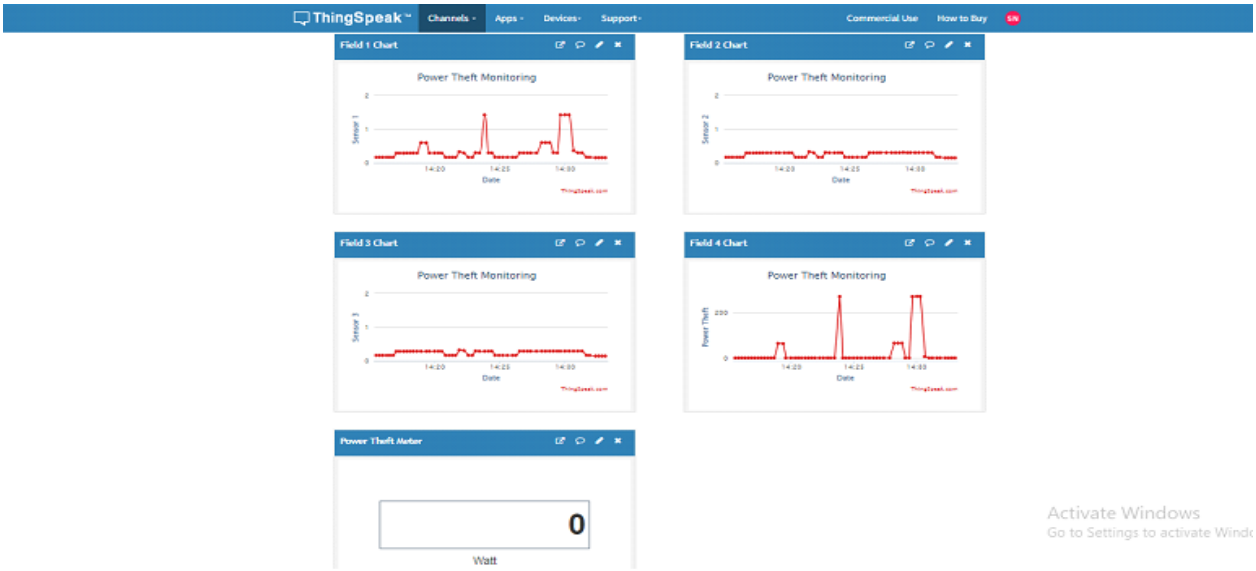

Figure 5.3: Real Time Data When No Power Theft

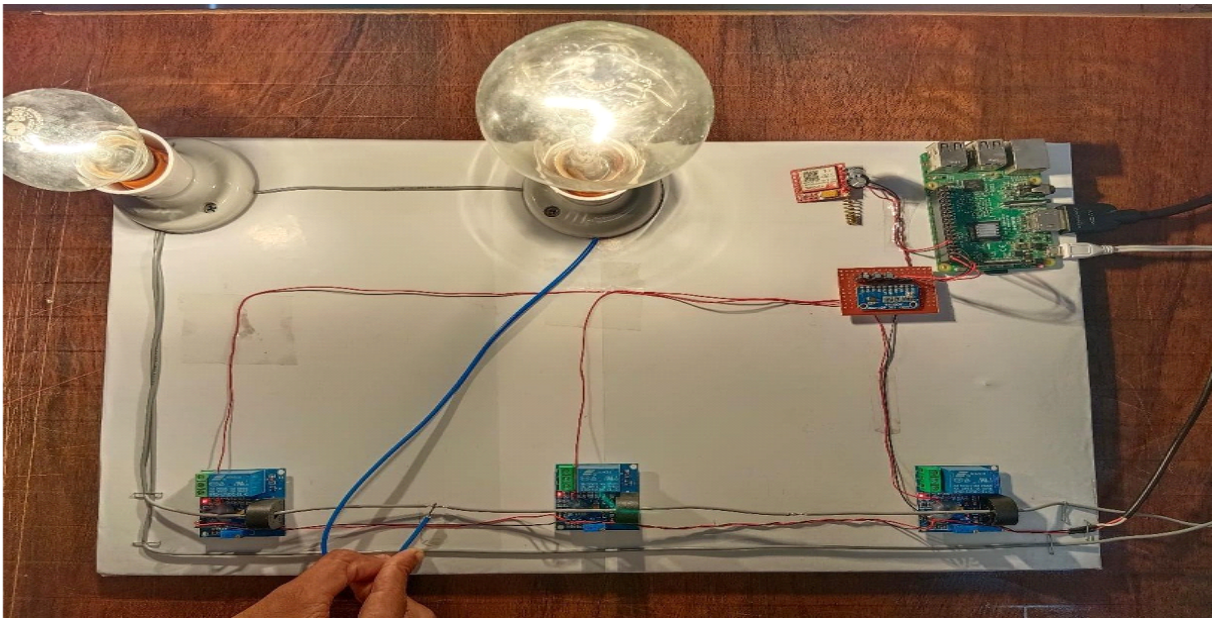

Figure 5.4: Power Theft Detection

In Power Theft Monitoring System, when any illegal load is connected the transmission lines current is increased and the current transducers send the data to the raspberry pi. Raspberry pi detects theft occurred in transmission line and calculate how much power is consumed by the theft. In that case we use 200W lamp as a theft load, raspberry pi calculated the theft power and upload it with the all data on thingspeak server.

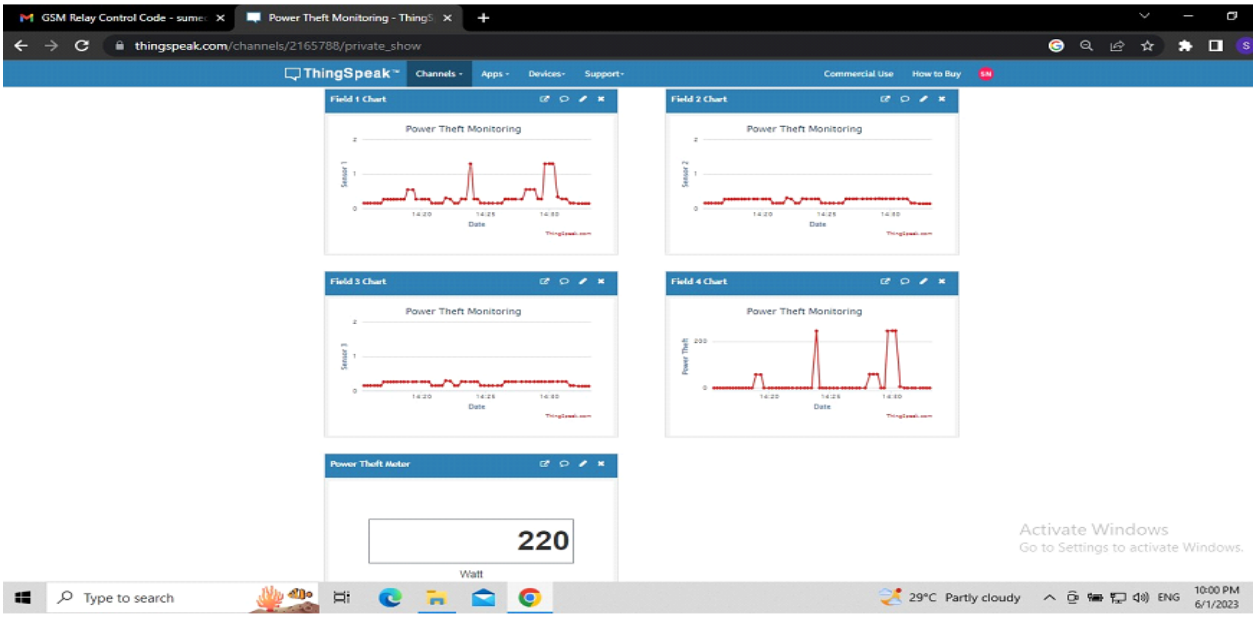

Figure 5.5: Thingspeak Server

This ThingSpeak server show the all uploaded values and also shows the how much power is consumed by theft which is 220W.

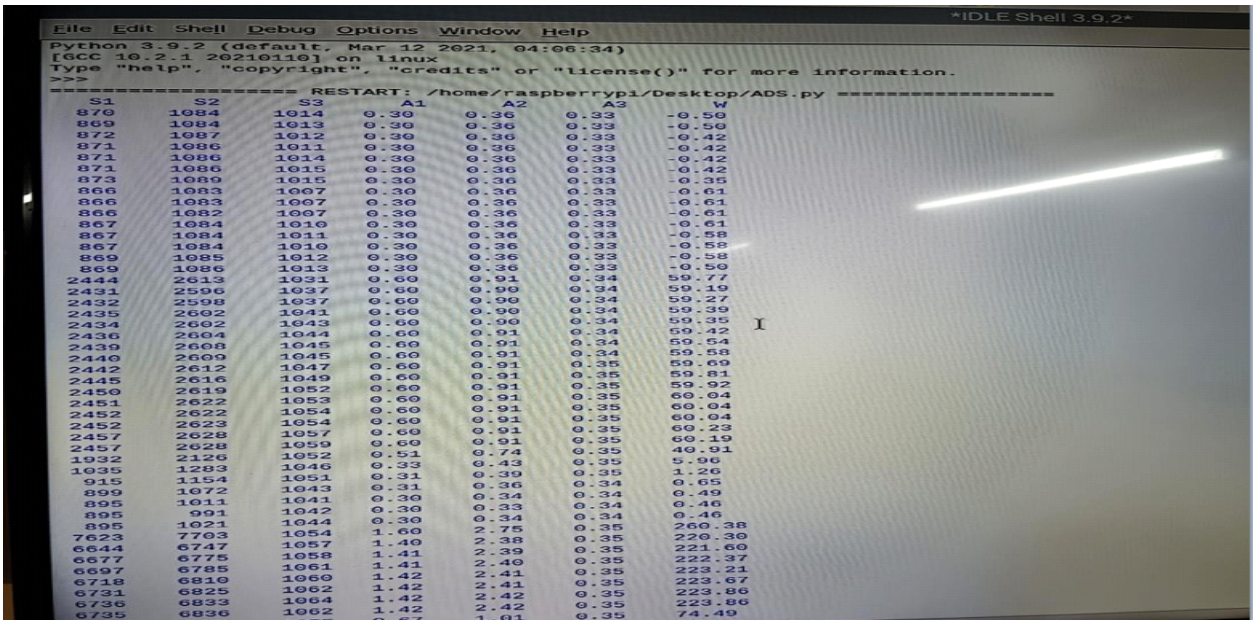

Figure 5.6: Current Sensor Output According to Theft Conditions

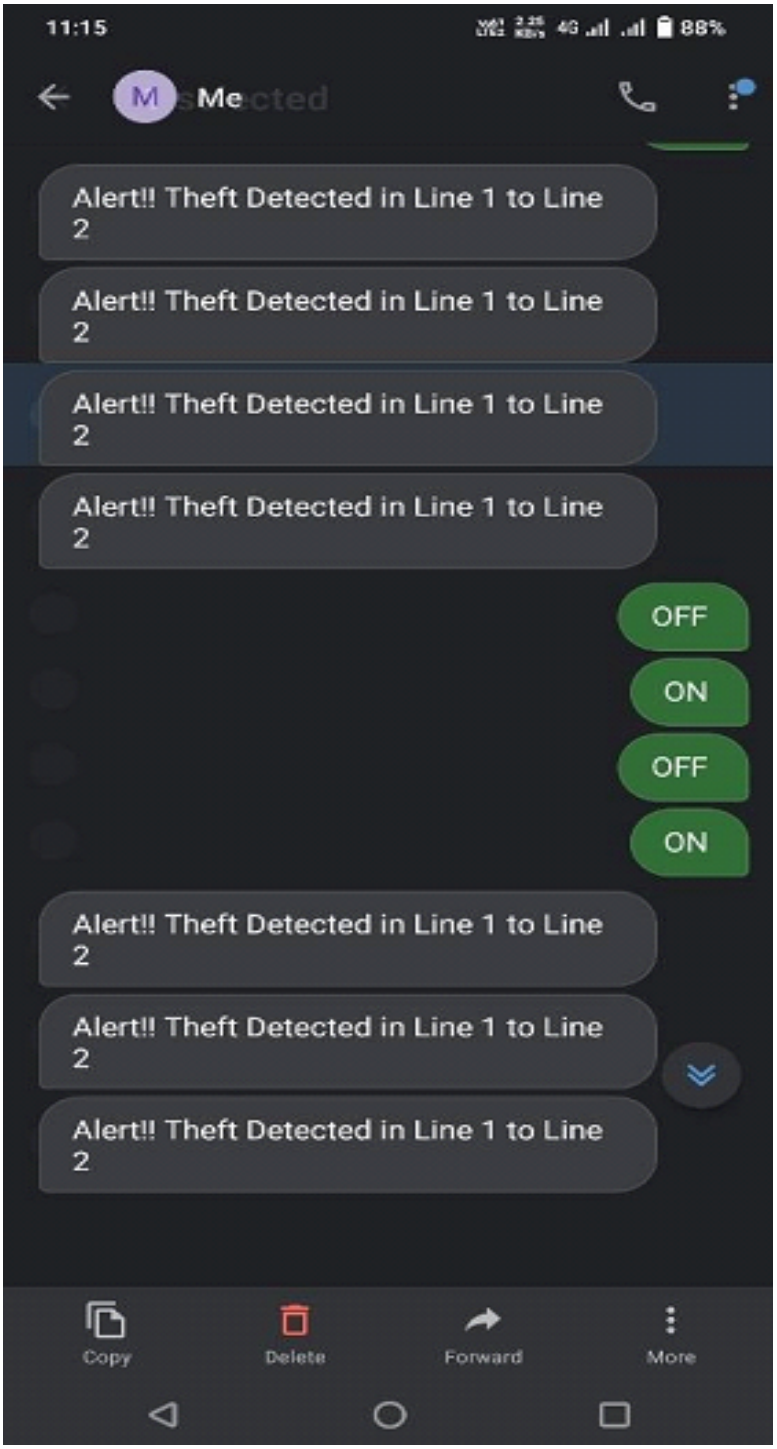

Figure 5.7: Result of Power Theft Alert

In Power theft monitoring and monitoring system, when power theft is detected at any location then raspberry pi sends an Alert!! Text message to the MSEB. And if the MSEB operator wants to cut off the transmission lines power the operator send specific commands to control the transmission line power. Command is “ON” and “OFF”.

Chapter 6

OTHER SPECIFICATION

6.1 Advantages

- The proposed system provides the solution for some of the main problems faced by the existing Indian grid system, such as wastage of energy, power theft, manual billing system, and transmission line fault.
- This method will reduce the energy wastage and save a lot of energy for future use. We can detect the location from where the power is being stolen which was not possible before.
- Optimized use of energy. Real time theft monitoring Currently used energy meters can be modified into this sensor, so no need to replace currently used energy meters. If the power is not stolen then the power is saving.
- The proposed system provides the solution for some of the main problems faced by the existing Indian grid system, such as wastage of energy, power theft, manual billing system, and transmission line fault.
- Optimize use of energy System can be monitored and controlled from anywhere

6.2 Limitations

1. Limited Range: The monitoring system may have a limited range, which could affect its ability to detect power theft in areas that are far from the Raspberry Pi device.
2. Power Supply Dependence: The system relies on a continuous power supply to function properly. Any disruption or failure in the power supply could impact the monitoring capabilities.
3. Data Accuracy: The accuracy of the data collected by the system may be influenced by various factors such as environmental conditions, interference, or technical limitations of the Raspberry Pi device.

4. Scalability: The system's scalability may be a limitation, especially if you plan to monitor a large number of power connections. The Raspberry Pi device might have limitations in terms of processing power and memory to handle a high volume of data.

6.3 Application

- Factories.
- Industrial Area.
- MSEB Substation.

Chapter 7

CONCLUSION AND FUTURE SCOPE OF WORK

7.1 Conclusion

In conclusion, Power Theft Monitoring using Raspberry Pi 3B presents a compelling solution for addressing the issue of electricity theft prevalent in both residential and commercial areas. The Raspberry Pi 3B, renowned for its affordability and compact design, serves as an ideal platform for seamlessly integrating with power meters to monitor real-time power consumption. Through meticulous analysis of power consumption patterns, the system can swiftly detect any irregularities or suspicious activities indicative of power theft. This invaluable information can then be promptly relayed to relevant authorities or power companies for further investigation and necessary action. By leveraging the capabilities of Raspberry Pi 3B for power theft monitoring, communities can establish a robust defense mechanism against illicit electricity consumption, thereby fostering a culture of fair and equitable utilization of power resources. Nonetheless, to ensure the efficacy and reliability of such a system, meticulous attention must be paid to the installation and configuration process. It is imperative to implement stringent protocols to mitigate the risk of false alarms or erroneous readings, which could potentially undermine the credibility of the monitoring system. In essence, the utilization of Raspberry Pi 3B for monitoring power theft not only offers an effective means of combating this pervasive issue but also embodies a proactive approach towards promoting responsible energy consumption practices within society. As technology continues to evolve, embracing innovative solutions such as this promises to play a pivotal role in safeguarding the integrity of our power infrastructure for years to come.

7.2 Future Scope of Work

The future scope of power theft monitoring using Raspberry Pi 3B is quite promising. Some of the potential developments that could be seen in this area include:

- Integration with smart grids: With the advent of smart grids, the power theft monitoring system could be integrated with these grids to provide a more comprehensive solution. This would enable real-time communication between the monitoring system and the grid, allowing for more accurate and efficient monitoring of power usage.
- Use of machine learning algorithms: Machine learning algorithms could be used to analyze the power consumption patterns and identify any anomalies or suspicious activity more accurately. This would reduce the incidence of false alarms and improve the efficiency of the monitoring system.
- Remote monitoring: With advancements in internet of things (IoT) technology, the power theft monitoring system could be remotely monitored from a central location. This would enable the authorities or power companies to keep track of the power consumption patterns in real-time and take necessary action if any discrepancies are observed.
- Expansion to industrial sectors: The power theft monitoring system could be expanded to industrial sectors, where the magnitude of power theft is often higher. This would require the development of more advanced algorithms and sensors to monitor the power consumption patterns in such sectors. Power theft monitoring is vast and holds a lot of potential for further development and expansion. With the integration of new technologies, the system could become more efficient and effective in combatting electricity theft in both residential and industrial sectors.

APPENDIX A
RESEARCH PAPER AND CERTIFICATES

APPENDIX B
PROJECT EXHIBITION CERTIFICATES

APPENDIX C
PLAGARISM RESULT

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